A Bioeconomic Framework for Economic Development

The basic objectives of Chambers of Commerce and community development organizations can be traced to a single basic theme: every locality wants to get its fair share of economic growth. In the United States it is largely taken for granted that growth is the normal state of affairs. Politicians are elected with a mandate to stimulate and sustain growth. Economists try to explain and predict it. Businesses invest in growth through purchases of capital and more productive technology. Planners work to attract the types of growth needed and desired by their jurisdictions. And citizens do their part through procreation and increasing per capita consumption of goods and services.

It is a tidy operation, and the 1980-1983 recession notwithstanding, economic performance in recent decades has enabled almost everybody to improve their material welfare. From 1960 to 1980, population grew by 26 percent, real per capita income increased 59 percent, and gross national product (GNP) more than doubled. In the same period, the aggregate income distributed to the poorest fifth of the nation's families increased from 4.8 percent to 5.3 percent of total U.S. income. This is an admirable record, and judging from recent trends, the economy is again ready to get back on the growth track. On March 9, 1983, Standard and Poor's Corporation released new economic projections which called for real GNP to increase at an annual rate of five percent during the latter half of 1983.

No doubt, growth has been and will continue to be of vital importance to society for some time to come. Without an expanding economy, individuals, income classes, towns, and regions are set against each other in competition over limited resources. Development options become restricted, and both employment and tax revenues lag. Despite growth's historic function as a safety valve for political tension, is it reasonable to assume that growth will continue indefinitely? Are policy-makers acting responsibly when they assure the public that growth is perpetually sustainable? Can development practitioners deliver the promises of public pronouncements that say "we'll get the economy moving again?"

The answer is no, not if one examines the economic process from the perspective of natural laws instead of the conventional assumptions of man. "Bioeconomics" allows just such a natural perspective. It is a hybrid theory of economic systems which combines principles from biology, economics, and thermodynamics. Derived largely from the work of economist Nicholas Georgescu-Roegen, bioeconomics is a direct assault on standard assumptions that create expectations of perpetual growth. Bioeconomics particularly challenges the persistent faith in unlimited resources and infinite technological achievement.

Why, one might ask, should we mess with a good thing? Bioeconomics argues that growth is not a good thing if it is based on questionable, unspoken assumptions. Growth of this type ultimately leads to breakdown, instability, and painful dislocation. Growth of this sort may also severely curtail the opportunities available to future generations.

Isn't bioeconomics just another version of the pessimistic, limits-to-growth argument? In fact, bioeconomics does suggest a physical constraint to growth. This constraint need not, however, be a cause for despair. Bioeconomic principles lead one to be more discriminating about the kind and timing of growth. The principles are based on nature rather than the uncertain foundation of human economics. As such, bioeconomics offers more durable guidelines for achieving realistic, sustainable objectives.

Won't candidates for public office and voters resist the notion that slowed growth is inevitable? Generally, yes. Candidates don't often campaign on platforms that suggest lowered expectations, and unemployed workers don't like to be told that factories won't reopen. But considering the chronic unemployment, cyclical instability, and policy ineffectiveness of the last decade, isn't it important to ask whether we're still playing the same economic game as we were ten or twenty years ago?

The rest of this article will show how bioeconomic principles contrast with the assumptions of conventional economics. In addition, some of the themes and criteria that emerge from a bioeconomic view of development will be discussed.

Energy Basis for Bioeconomics

Because all materials and organisms are composed of energy in some form, bioeconomic

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analysis uses the language of energy. Economic processes are viewed in terms of energy flows and the ability of those flows to perform useful work. The use of energy measurements thus allows comparisons among the natural energy values of different fuels, minerals, goods, and services.

The First and Second Laws of Thermodynamics describe the main quantitative and qualitative distinctions of bioeconomics. The First Law states that the total energy of a closed system is constant. Energy is neither created nor destroyed in the economic process; it is conserved. Even though humans or nature may concentrate or otherwise transform energy, the total energy quantity stays the same.

The Second Law, or Entropy Law, is the real key to bioeconomics. It states that there is a constant tendency for order to turn into disorder. Alternatively, one could say that in a closed thermodynamic system, all matter and energy are constantly and irreversibly deteriorating from an ordered to a disordered condition. Only when energy is added from outside the system can order be increased.

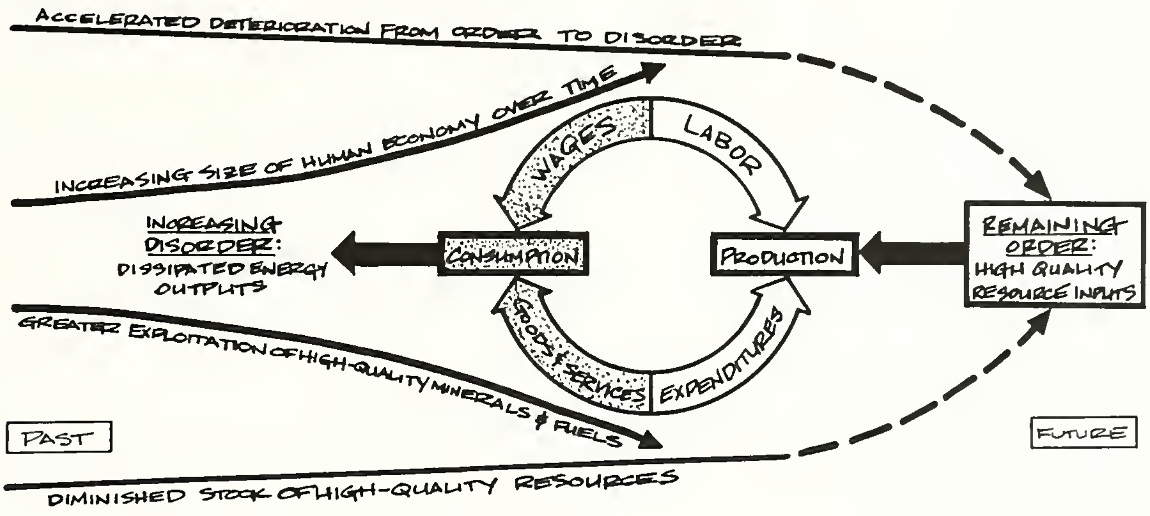
The introduction of relative order and disorder is very important in bioeconomics, for it adds a new, qualitative dimension to the economic process. High-quality matter is ordered. It contains high levels of potential energy stored in an organized structure. When the potential energy is released, it can be used for work. Examples of high-quality energy are coal, grass, and information. All three represent, in essence, concentrated forms of energy. On the other end of the qualitative spectrum is decayed energy. Here one finds coal molecules after combustion, grass following decomposition, and outdated information. In each of these cases order and structure has deteriorated. Total energy is not lost, but it has instead been dispersed and made unavailable for useful work.

The Bioeconomic Process

In conventional economics, value is based on utility, scarcity, and the production work done by people during the economic process. People are credited with creating part of the value of goods and services. On the other hand, bioeconomics attributes the primary source of value to the qualitative energy characteristics of goods and services themselves. Something must still have utility in order to have value. However, the bioeconomic measure of that utility is the relative concentration of available energy: the greater the ability of a resource to do work, the greater its value. The earth's terrestrial supply of non-renewable materials is the stock, or capital source, of valuable, high-quality energy. The diffuse flow of energy from the sun and the chain of renewable resources that it drives can be likened to the earth's current income.

The effects of entropy on bioeconomic value are significant. The paragraph above said that value was related to qualitative energy attributes. The higher the energy concentration and consequent ability to perform work, the greater the value. This means that most minerals and fuels have their greatest value at the start of the economic process. The economy actually accelerates the loss of order by increasing the rate of dissipation. Human and nature only increase the structure in selected parts of the system: fossil fuels, a human being, and even a shopping center are made possible through the reordering and concentrating work of natural and economic processes. Potential energy is stored and value increases. However, the total amount of high-quality energy in the system is not increased. No process, when viewed in its entirety, is a "net gainer" of high-quality energy. Thus, despite our efforts to reorder and repackage materials, total bioeconomic value always declines.

The effects of entropy are also seen in the bioeconomic view of exchange. Conventional economics assumes that money and goods flow in a reversible cycle. Resources come in one end; waste is deposited out the other. As exchange takes place, neither the value of the money nor the value of the resources is assumed to change over time. It is as if the natural resources themselves never run out or decline in quality. Bioeconomics shows why this is not the case. The human economy, like any other organism, moves along the path of entropy toward disorder. The movement has only one linear direction and it cannot be reversed. Thus, the value of



stocks and the consequent ability to process flows, is always diminished. In the exchange cycle, a given amount of money buys less and less available energy.

Conventional economics is guided on the aggregate level by the combined principles of neoclassical and Keynesian theory. The maximization of individual satisfaction is assumed to lead to both an optimal allocation of macroeconomic resources and a greater level of consumption. If consumer demand doesn't have enough money behind it to make it effective, as occurred during the Depression, then the public sector can stimulate demand and investment.

Bioeconomics is guided by a biological principle known as the maximum power principle. Simply put, it says that those systems survive which maximize the use of available energies in their work activities. The potential energy contained in society's reservoirs is used most effectively when it is fed-back to collect and store less concentrated energies. For example, a high-quality energy such as coal is wasted if it is not used in an interaction that builds up and replenishes energy stores. Coal-fired electric plants, if used to generate power for a non-feedback purpose such as resistance heat, is not energy-effective. The same power is effective if it is used to mine greater amounts of coal. Thus, the allocation of resources in bioeconomics is based on energy quality (how much work can it do?) and the kind of work being done (will it make the system more competitive?)

Returning to the conventional assumption of perpetual material progress, we are told by standard economists that continued growth in production and consumption (as measured by GNP) is desirable and possible. Another definition of growth, offered by Howard Odum (1976), is that it is a state of "expanding storages of structures, energy reserves, population, information, and order." The expansion is made possible by producing positive net energy; that is, high-quality inflows have to exceed the outflows used for the following:

1) generating new, high-quality resources;

2) maintaining or replacing old structures;

3) accommodating population increases; and

4) compensating for the diminishing returns involved in using greater amounts of energy just to find and process less-accessible resources.

With all these requirements, real growth cannot be assured indefinitely. Like all organisms, an economy reaches a stage where it has difficulty maintaining positive net energy. This is especially true as the finite resource base declines in energy value. In order to survive, the mature economy must learn to live within its means.

It is at this point that conventional economics wheels out its heavy hitter, the principle of unlimited substitutability. This principle claims that society will never exhaust its supply of essential resources because it will always find a substitute. Technology, as the source of increased productivity or as the pioneer of new uses for remaining materials, is considered the agent of perpetual salvation. Following this logic, Thurow (1980) says that finite resources are actually becoming more available to the economy.

From the perspective of bioeconomics, Thurow's talk is reckless and narrow-minded. It does not recognize the importance of energy quality and appropriate use. Consider the use of "unlimited suitability" as an argument for nuclear power. Are the net energy consequences (after taking construction, maintenance, safety, transmission losses, and decommissioning into account) actively considered in public discussion? No! Consider the current faith in solar energy future. How much, and what kind of, finite fuels and minerals will be required to construct, maintain, and replace millions of solar arrays? It is not often discussed. And finally, consider the hope that more efficient recycling will be able to recover increasing amounts of our mineral resources. How much high-quality energy will be needed from other sources just to achieve such unheard-of efficiencies? Probably more than its worth in bioeconomic terms.

Will net energy be increased in any of the uses above? It certainly will not in recycling. Solar energy is at this stage a toss up (Rifkin, 1980). And even if a particular nuclear plant does generate positive net energy, it is important to ask for what purpose the net energy is used. In none of these cases is the total energy of the entire system increased.

The Bioeconomic Development Framework

When one applies the language of energy and the principles of bioeconomics to economic development, it becomes possible to envision the entire development process as one would any other living organism. An organism develops through different stages, reaches a peak, and then settles into a mature state. The ability of the organism to thrive throughout the mature stage is dependent upon the choices it makes. As Randall (1981) says: "Societies that choose well increase the possible range of possible choices for their citizens, over the long haul."

Various authors have suggested a number of guiding themes to help development practitioners choose well. William Miernyk (1982) advocates thrift: one should get as much work as possible out of as little energy as possible. Herman Daly (1980) pushes for durability: a planner evaluating a project should ask how long it will last and how efficiently it can be recycled. Howard Odum (1976) says that diversity of energy sources and uses is a way to make systems more stable. David Morris (1982) stresses the importance of local self-reliance in helping areas attain a measure of control over their development futures. Finally, Joseph Schumpeter (1961) is credited with making the important distinction between growth and developmemt. They are not the same. Growth means putting more materials through the system. Development refers in strict terms to innovation, increased efficiency, and adaptation. Bioeconomics emphasizes the need for development rather than growth.

What goals and measures are available for use in a bioeconomic framework? To start, planners might consider strategies and projects that reduce the per capita energy consumption of their jurisdiction. Second, practitioners could evaluate the energy and financial costs of projects over their entire life-cycle. Third, projects could be given favorable treatment if they use local renewable resources rather than imported stocks. And fourth, planners could begin to trace the net energy effectiveness of different development alternatives.

These are but a sampling of the bioeconomic concepts that can be applied in addition to current development techniques. On their face, they appear reasonable and even wholesome. However, when applied in practice, bioeconomic themes and criteria may be unsettling for many established interests. Growth assumptions and conventional wisdom have not prepared our society to face anything less than sustained material growth. Bioeconomics offers a rationale, based on natural principles, for beginning the preparations necessary for sustained and sensitive development.

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